NON-PUBLIC?: N
ACCESSION #: 9011150240
LICENSEE EVENT REPORT (LER)

FACILITY NAME: Brunswick Steam Electric Plant Unit 2 PAGE: 1 OF 07

DOCKET NUMBER: 05000324

TITLE: Unit 2 Reactor SCRAM on Turbine Stop Valve Fast Closure Caused by
a Reactor High Level when a Fuse failed in the Feedwater Control
System Circuitry.
EVENT DATE: 10/12/90 LER #: 90-016-00 REPORT DATE: 11/08/90

OTHER FACILITIES INVOLVED: DOCKET NO: 05000

OPERATING MODE: 1 POWER LEVEL: 100

THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10
CFR SECTION:
50.73(a)(2)(iv)

LICENSEE CONTACT FOR THIS LER:
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COMPLIANCE SPECIALIST

COMPONENT FAILURE DESCRIPTION:
CAUSE: X SYSTEM: JK COMPONENT: FU MANUFACTURER: G182
REPORTABLE NPRDS: Y

SUPPLEMENTAL REPORT EXPECTED: No

ABSTRACT:

On October 12, 1990, the Unit 2 reactor was at 100% power and 1005 psi. The Emergency Core Cooling Systems were operable, in standby readiness. A functional check was in progress on a thermocouple mV/I module in the feedwater control cabinet, H12-P612, located in the control room back-panels. Fuse 2-C32-F3 is part of the circuitry which powers the referenced module. At 14:01:52, a high reactor level was detected. This resulted in a reactor scram turbine stop valve fast closure, per design. The control rods inserted and turbine bypass valves acted to control reactor pressure at 1005 psi. The scram was caused by a failure of the Gould Shawmut fuse 2-C32-F3 in the FWCS. The failure resulted in a false low level signal to the B turbine driven reactor feed pump (TDRFP) control circuitry which, in response, increased the B TDRFP output and resulted in a main turbine trip on reactor high water level. The reason the fuse blew in the FWCS has not been determined. The Gould Shawmut fuses have been sent to the CP&L Harris Energy & Environmental center for further testing and examination. In addition, an event recorder is currently monitoring the power supply circuitry to the 2-C32-F3 fuse. Past similar events include LERs 2-90-08 , 2-88-018 and 1-88-023. The safety significance of this event is minimal. Plant systems responded as designed and the event is bounded by the analysis in the Final Safety Analysis Report, Feedwater Control System failure.

END OF ABSTRACT

EVENT

Reactor scram caused by Turbine Stop Valve (TSV) closure when the main turbine tripped on high reactor water level. The water level transient was a result of a failure in the Feedwater Control System (FWCS).

INITIAL CONDITIONS

On October 12, 1990, the Unit 2 reactor was at 100% power and 1005 psi. The Emergency Core Cooling Systems were operable, in standby readiness.
Reactor level was within the normal operating band at 187 inches. It was being controlled, in three element, automatically, by the master feedwater level controller. A functional check was in progress on a thermocouple mV/I module in the feedwater control cabinet, H12-P612, located in the control room back-panels. Fuse 2-C32-F3 is part of the circuitry which powers the referenced module.

EVENT DESCRIPTION

At 14:01:26, on October 12, 1990, fuse 2-C32-F3 blew and the 115 Vac primary power supply was lost to a number of modules in the FWCS. The loss of power resulted in a loss of feedback to the master level controller and level recorder and the low reactor water level alarm was received. An alarm unit monitoring the control loop for loss of signal to the "A" Turbine Driven Reactor Feedwater Pump (TDRFP) locked the speed of the turbine and the "A" TDRFP did not increase speed in response to the false "low level". However, the "B" TDRFP speed increased in response to the "low level" seen by the master controller. At 14:01:44, the reactor recirculation (RR) pumps received a runback signal following a time delay and decreased speed, per design. The decreased recirculation flow caused vessel level to swell, due to increased voiding, which accelerated the increase in reactor level. At 14:02:01, because the TDRFPs tripped off line, the Reactor Protection System (RPS), low level 1, trip setpoint was reached and the Group 2, 6, and 8 Primary Containment Isolation System (PCIS) isolation signals were received. Groups 2 and 6 isolation valves closed, Group 8 isolation valves were closed prior to the event. In accordance with site Emergency Operating Procedures (EOPs), the reactor mode switch was placed to "shutdown" which resulted in a half Group 1 PCIS isolation signal because of the sensitivity of the trip unit B21-N008C-2. At 14:02:19, the lowest reactor water level was reached during the event, 115.4 inches. The RPS low level 2 (Technical Specification setpoint >/= 112 inches) signal resulted in an Alternate Rod Insertion (ARI) trip, tripping of both RR pumps, an isolation command to PCIS Group 3 and an automatic initiation signal to the High Pressure Coolant Injection (HPCI) and the Reactor Core Isolation Cooling (RCIC) system, as designed. The PCIS Group 3B did not receive its isolation command. The Reactor Water Cleanup (RWCU) system tripped, per design, when the inboard isolation valve closed in response to the Group 3A isolation signal. At 14:02:30, RCIC injection began. At 14:02:33, the HPCI turbine accelerated to speed but did not inject, by design, because level had returned to 123 inches and the low level 2 permissive was no longer present. The HPCI turbine continued to run at rated speed on minimum

flow. At 14:03:03, after a number of attempts, the "A" TDRFP trip was reset by the RO. Initially the A TDRFP trip signal would not reset, but, by holding the reset switch in the reset position the RO unintentionally caused fuse 2-C32-F2 to blow allowing the TDRFP trip circuit to be reset.

At 4:03:25, the RO opened the HPCI injection valve to help restore level. At 14:05, the reactor level was restored above the low level 1 setpoint and the RO closed the HPCI injection valve. At 14:06, the RO placed HPCI in the pressure control mode. It should be noted that the TBVs were maintaining reactor pressure satisfactorily and this was not an action required to control pressure. At 14:10, the control rods were confirmed to be full in. At 14:13, the PCIS groups 2 and 6 isolation logics were reset. At 14:15, HPCI was manually tripped. At 14:17, the RO was able to reset the half Group 1 isolation signal. At 14:18, the "B" TDRFP was reset and started. At 14:21, the SULCV was placed in service. At 14:22, RCIC injection was secured. At 14:26, the RO reset the ARI signal, the SCRAM signal, restored reactor building ventilation and secured the Standby Gas Treatment trains. At 14:34, the EOPs were exited and General Plant (GP) Procedure 05, Unit Shutdown, was entered. At 14:46, the 4 and 5 feedwater heaters were isolated when steam was reported in the feedwater heater rooms; the relief valves had lifted. Two attempts were made to start the "A" RR pump but the breaker immediately tripped. The undervoltage flags were found tripped on both the "A" and "B" RR pumps, they were reset, and the "B" RR pump was started. At 15:09, the FWCS mode selector was placed in single element and the B TDRFP discharge pressure, which had been at greater than 1500 psi, decreased to approximately 1200 psi. At 15:11, the A TDRFP was started in manual. Feed to the vessel was established at approximately 750 psi and the RO manually backed down the B TDRFP. The B TDRFP was manually tripped at 15:29.

EVENT INVESTIGATION

The 2-C32-F3 (3 ampere) fuse was removed from its fuse holder in control room back panel 2-H12-P612. It was noted that the fuse was securely held in place by the fuse clips. It was verified to be the correct fuse, Gould Shawmut Amp-Trap A25Z3, Type 2. The individual fuses associated with the nine Gemac components powered from 2-C32-F3 were inspected, except the fuse associated with 2-C32-PY-N005A, a reactor vessel pressure transmitter which feeds an indicator. Its fuse was not accessible, however, it was verified to be operating correctly after the circuit was re-energized. Therefore, a possible internal fault on 2-C32-PY-N005A, which would cause 2-C32-F3 to blow, was ruled out. Each of the referenced fuses are Bussman AGC 1 ampere, and none were blown. A test setup utilizing a visicorder was connected to the circuit to determine in rush current upon energization. The in rush of current was approximately 5.43 amperes and approximate duration was 1/2 cycle or 8.33 milliseconds. The normal load current was approximately 1.11 amperes. The A25Z3 fuse curve was referenced, and the 5.43 amperes would have to remain on the fuse for 10 seconds before the fuse would clear. When the circuit was re-energized during testing, the test fuse did not open. Prior to the reactor scram, Instrumentation and Control (I&C) technicians were in panel 2-H12-P612 taking thermocouple measurements with a Micromite at terminals 1 and 3 on 2-C32-N600A, a feedwater temperature converter. The 120 volt feed for this device is powered via the 2-C32-F3 fuse. The

Micromite and test leads were inspected and no physical damage was noted. As part of the testing, the measurements were repeated with the visicorder monitoring the load current. Test leads were connected, disconnected and reconnected utilizing the same equipment used prior to the event. Variations in load current were not noted. Each of the Gemac instruments and associated ribbon cables, powered from the fuse, were inspected for physical damage. A wire in 2-C32-K608, a steam mass flow rate alarm unit, was found to be skinned but further investigation revealed that the wire was a case ground which could not come in contact with power wiring and cause the fuse to blow. The instrument covers were removed and the circuitry inspected. A loose screw was found lodged between relay terminals 7 and 8 in 2-C32-K624A, associated with the high level reactor vessel trip to the turbine. Further investigation revealed that relay terminals 7 and 8 are connected to TB1-14 and TB1-11, respectively. No external connections exist on TB1-14 so this could not have created a problem (ie, short circuit). The Bussman AGC 1 ampere input fuses to each component powered from the 2-C32-F3 fuse were removed and the power wires lifted at 2-C32 PY-N005A and taped. The power circuit to 2-C32-F3 was meggered at 100 volts and 250 volts with resulting measurements to ground in excess of 1000 megohms in both cases. The wiring was reconnected and the fuses were re-installed. Accessible wiring from the 2-C32-F3 power circuit to each of the instruments was inspected. No damage was found that could have caused the 3 ampere fuse to blow. No fault has been found within the circuitry powered by the 2-C32-F3 fuse which could have caused it to blow. Engineering Evaluation (EER) 90-0262 has allowed the temporary replacement of the Gould Shawmut fuses, in the Unit 2 feedwater control circuitry, with Bussman MIN fuses. The Gould Shawmut fuses have been sent to the CP&L Harris Energy & Environmental center for further testing and examination. In addition, an event recorder is currently monitoring the power supply circuitry to the 2-C32-F3 fuse.

Similar testing was performed on TDRFP lockout circuit fuse 2-C32-F2 which is a Amp-Trap A25Z10, type 2. This fuse failed when the operator held the reset knob. The trip current for the K2A relay was approximately 19.46 amperes and approximate duration was 1/2 cycle or 8.33 milliseconds. An attempt was made to simulate the repeated reset attempts by the RO and the current was measured when the relay was held in the reset position. The reset current was measured and found to be approximately 17.93 amperes. The A25Z10 fuse would blow in 1 to 1.5 seconds with this load current. Therefore, the current drawn by the relay when it was repeatedly held in the reset position, was sufficient to cause the fuse to blow.

Following the scram the 2-B21-DPIS-N008C-2 remained tripped for several minutes causing the 1/2 Group 1 isolation logic trip signal to remain sealed in. The instrument loop setpoint is 6 psid increasing, which corresponds to less than 40% main steam flow. The range of the instrument is 150 psid. The electronic setpoint corresponding to the 6 psid is 4.64 milliamps (ma) plus or minus () 0.04 ma increasing with a full scale range of 4 ma to 20 ma. The setpoint will reset at approximately 4.34 ma decreasing. After a scram that does not isolate the main steam lines, steam continues to flow to the condenser via the TBVs for pressure control. During this mode of operation the instrument is near the low end of its scale and it is not unusual for the instrument to spike into the trip

range when variations in steam flow are introduced to the reactor such as restart of TDRFPs or when equalizing across the main stem line isolation valves.

A review of the calibration setpoints for the RWCU isolation valves found that the 2-G31-F001 low level instruments are set to actuate prior to the 2-G31-F004's. During this event, reactor level decreased to the point of actuating the closure of the 2-G31-F001 but not to the point of closing the 2-G31-F004. It should be noted that the instrumentation for both valves is within their acceptance tolerance range.

Following the high reactor water level trips on the reactor feedpumps and main turbine and subsequent reactor scram, the RO began restart procedures for the 2B TDRFP. At the time, EOPs were in use rather than the GPs. The EOP's do not contain detailed instructions for the feedpump controls. The applicable EOP steps only reference placing the SULCV in service along with a TDRFP. The RO closed the feedwater outlet valves and the 2B TDRFP discharge valve, opened the 2B TDRFP recirculation valve and raised 2B TDRFP speed using the motor speed changer (MSC). He then reopened the discharge valve to establish a flow path. At that time the motor gear unit (MGU) manual/automatic (M/A) station was in manual operation with minimum speed demand, and the master feedwater level controller was in three element automatic operation with its output at 100%. This was due to the controller feedback signal having failed downscale as a result of the blown fuse. The 2B TDRFP speed was increased, using the MSC, to the high speed limit and then increased further using the M/A station in the manual mode. At this point the M/A station was transferred to automatic and the feedpump began acceleration to full speed (5700 RPM) and discharge pressure increased to about 1700 psig. The 4 and 5 feedwater charge valves heater tube relief lifted and began releasing steam into the Feedwater Heater Room. The SULCV controller was set at 190 inches in automatic mode and the 2-FW-FV-V177 controller was adjusted to provide an output from the SULCV controller of approximately 60%. The system appeared at this point to be in relatively stable control of reactor level. Reports of steam being released in the Feedwater Heater Room led to the decision to isolate the 4 and 5 feedwater heaters by closing the inlet valves to each train. No changes were observed in the operation of the feedwater controls. At this point

the Operators began investigating the cause of the high 2B TDRFP discharge pressure and operating speed. It was noticed that the master feedwater level controller had not returned to the normal range after the level select switch had been placed in level "B". The system was placed in single element control and level
eedback was restored to the
controller. At this time the 2B TDRFP began a slow decrease in speed and discharge pressure. This was probably as a result of level increasing to slightly above the 190 inch setpoint. The discharge pressure reached a low of approximately 1200 psig and then began a slow increase (again level was fluctuating around setpoint). The decision was made to place the 2A TDRFP in service to determine whether the 2B TDRFP was suffering from a blocked flow path. The 2B TDRFP discharge valve was closed and the recirculation valve opened. The 2A TDRFP speed was increased to about 2500 RPM using the MSC and the discharge valve was opened. The 2A TDRFP discharge pressure was set at approximately 200 psig over reactor pressure (750 psig). The feedpump was left in this configuration while other preparations were made. The RO secured the

RWCU reject flow to help raise water level. The reactor water level began to increase and the 2B Reactor Feedpump rapidly decreased in speed and discharge pressure in response. As the two feedpump pressures equalized, the RO shifted the 2A TDRFP M/A station to automatic operation. He then removed the 2B TDRFP from service by placing it in manual operation and lowering the speed. At this point the start-up level controller output reduced to less than 50% and 2A TDRFP discharge pressure remained at approximately 750 psig. The 2B TDRFP was then manually tripped.

Based on the operating characteristics observed while the 2B TDRFP was in service, a test was run to ensure that its discharge check valve was capable of opening. The test did not identify the inability to open but could not conclusively rule out failure. The decision was made to inspect the valve internals. That inspection revealed no valve problems and in fact ruled out any possible valve failures.

It has been determined that the high differential pressures caused by unusually high reactor feedpump speed due to the blown fuse in the master level control circuits led to the SULCV's inability to properly respond to controller demands. The valve did respond, but because of the high differential pressure it was "sluggish". The valve's actual position was most likely significantly less open than demanded valve position. As the RWCU reject flow was secured and vessel level began to increase, the master feedwater level controller reduced the 2B Feedpump speed and discharge pressure to a point that the valve began operating normally. At that time the 2A Feedpump was placed into service and the 2B Feedpump was secured.

Past similar events include LERs 2-90-08, 2-88-018 and 1-88-023.

ROOT CAUSE AND CORRECTIVE ACTIONS

The reactor scram was caused by a failure of the Gould Shawmut fuse 2-C32-F3 in the FWCS. The failure resulted in a false low level signal to the B TDRFP control circuitry which, in response, increased the B TDRFP output and resulted in a main turbine trip on reactor high water level. The closure of the TSVs resulted in the reactor scram, per the design of RPS.

The reason the fuse blew in the FWCS has not been determined. Engineering Evaluation (EER) 90-0262 was written to allow the temporary replacement of the Gould Shawmut fuses, in the Unit 2 feedwater control circuitry, with Bussman MIN fuses. The Gould Shawmut fuses have been sent to the CP&L Harris Energy & Environmental center for further testing and examination. In addition, an event recorder is currently monitoring the power supply circuitry to the 2-C32-F3 fuse.

Additional training will be provided to operators on SULCV and TDRFP operation.

Other single failure point fuses, which could result in a scram if they blew, will be researched and required action, if any, will be identified and initiated.

EVENT ASSESSMENT

The safety significance of this event is minimal. Plant systems responded as designed and the event is bounded by the analysis in the Final Safety Analysis Report, Feedwater Control System failure. In the event that the high pressure coolant injection systems had failed, the Automatic Depressurization System (ADS) and the low pressure coolant injection systems were available.

EIIS

COMPONENT CODE COMPONENT CODE

2-C32-F2 JK/FU 2-C32-F3 JK/FU
2-FW-FV-177 SJ/V ADS *
ARI * FWCS JK
HPCI BJ PCIS JM
RCIC BN RR AD
RPS JE RWCU CE
SBGT BH SULCV SD/LCV
TDRFP TRB/SK TBV TRB/*
TSV TRB/SHV

(*) Component Identifier not found.

ATTACHMENT 1 TO 9011150240 PAGE 1 OF 1

CP&L
Carolina Power & Light Company

Brunswick Nuclear Project
P. O. Box 10429
Southport, N. C. 28461-0429

November 8, 1990

FILE: B09-13510C 10CFR50.73
SERIAL: BSEP/90-0759

U. S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, D. C. 20555

BRUNSWICK STEAM ELECTRIC PLANT UNIT 2
DOCKET NO. 50-324
LICENSE NO. DPR-62
LICENSEE EVENT REPORT 2-90-016

Gentlemen:

In accordance with Title 10 of the Code of Federal Regulations, the enclosed Licensee Event Report is submitted. This report fulfills the requirement for a written report within thirty (30) days of a reportable occurrence and is submitted in accordance with the format set forth in NUREG-1022, September 1983.

Very truly yours,

J. L. Harness, General Manager
Brunswick Nuclear Project

TMJ/

Enclosure

cc: Mr. S. D. Ebneter
Mr. N. B. Le
BSEP NRC Resident Office

*** END OF DOCUMENT ***